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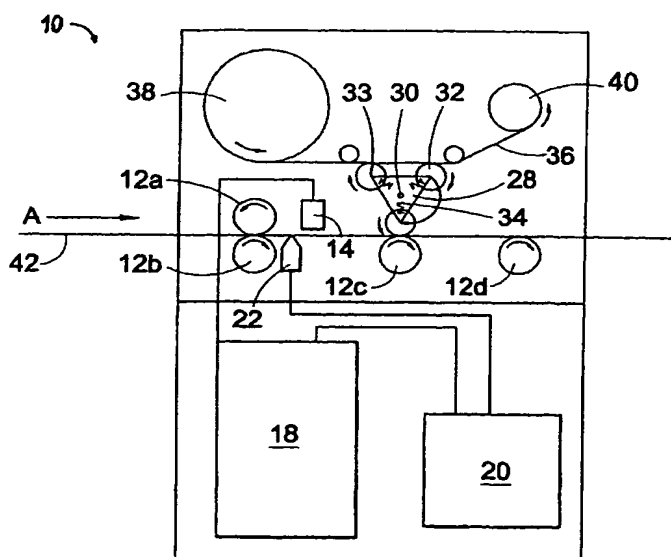
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(54) Title: SUBSTRATE CLEANING



(57) **Abstract:** An apparatus 10 for cleaning a printed circuit board (PCB) is disclosed, the apparatus 10 having a vacuum bar 14 and air knife 22 disposed either side of a PCB pathway through the apparatus. The air knife 22 and vacuum bar 14 loosen contaminants from a PCB passing through the apparatus, which contaminants are subsequently collected by tacky roller arrangement comprising three tacky rollers 32 mounted on a rotatable support frame 28. The rollers 32 are cleaned by a tacky sheet 36 passing above and in contact with the rollers 32, so allowing continuous cleaning of the PCB and refreshment of the rollers 32.



CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

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SUBSTRATE CLEANING

The present invention relates to an apparatus and method for removal of contaminants from a substrate surface. In particular, though not exclusively, the invention relates to an apparatus and method for removal of adhesive paste or the like from the surface of a printed circuit board (PCB) substrate.

Placing and securing components such as integrated circuits and the like, of printed circuit boards (PCBs) in high volume production is a rapid, fully automated process usually carried out on an assembly line. The medium used to secure the components is usually a "solderpaste" or adhesive which is screenprinted onto the PCB substrate. The electronic components are then placed by robotics in the appropriate positions.

Occasionally the screenprinting process does not give complete accuracy, and the adhesive may then be misaligned. Where a board has been incorrectly printed it is preferred to remove the adhesive to enable the board to be reused; this avoids the cost of scrapping the board.

Cleaning and removal of adhesive must also be performed periodically for the screens or stencils used during the screenprinting stage.

Conventionally used cleaning processes involve the use of solvents and the like, together with jets of water or

solvent to dislodge the adhesive in a so-called "wet" cleaning process. The process may be performed manually, although it is commonly automated, being conducted in specially-produced cleansing units.

5 However, this industrialised wet cleansing process suffers from a number of disadvantages. The cleaning units are relatively bulky, typically with a footprint of over one square metre. Wet process waste is difficult to deal with, giving rise to issues of environmental contamination, hazardous waste, and the like. Further, the cleansing
10 units themselves must be plumbed in, making them unsuitable to rapidly-changing production lines. The parts to be cleaned have to be removed from the production line and taken to the washing station, while further delay arises
15 while sufficient "dirty" screens and boards are accumulated to make the washing process cost effective, with the washing cycle itself taking as much as five minutes. Finally, washing a PCB substrate in a wet process leaves the board liable to delamination.

20 It is among objects of embodiments of the present invention to obviate or alleviate these and other disadvantages of conventional substrate cleansing systems.

 According to a first aspect of the present invention, there is provided an apparatus for cleaning a surface of a
25 substrate, the apparatus comprising a tacky surface for contacting a substrate surface, moving means for moving a

substrate and the tacky surface relative to one another, and fluid pressure varying means for altering a pressure of a fluid adjacent a portion of the substrate.

5 In use, therefore, the tacky surface and the substrate surface are moved relative to one another, the tackiness serving to transfer contaminants, such as solder paste, from the substrate to the tacky surface. The fluid pressure varying means aids in loosening contaminants from the substrate, so assisting the cleaning process.

10 Preferably the substrate is a printed circuit board (PCB) substrate.

The fluid pressure varying means may comprise a gas blower means which may cause localised pressure increases at or adjacent to the substrate surface.

15 The fluid pressure varying means may also comprise a gas suction means which may cause localised pressure decreases at or adjacent to the substrate surface.

The gas blower means may blow air or alternatively any other suitable inert gas.

20 The gas blower means, in use, may cause contaminant loosening and removal, and the gas suction means, in use, may cause contaminant removal and collection.

25 Preferably the fluid pressure varying means varies air pressure adjacent the substrate; alternatively, any other suitably inert gas may be used. This gives a completely "dry" cleaning process, in contrast to conventional "wet"

cleaning processes. However, liquid fluids may instead be used, such as water, if the nature of the cleaning process is not an issue.

5 Preferably the fluid pressure adjacent the substrate is decreased; this provides a suction force to remove loose particles of contaminant from the substrate. The apparatus may then further comprise a vacuum trap or the like, to receive and store removed contaminant particles.

10 Alternatively, or in addition, the fluid pressure adjacent the substrate may be increased. For example, an air knife or the like may be used. This will also serve to loosen contaminants from the substrate surface. The increased pressure may be applied on the same surface of the substrate as is to be cleaned, or on the opposite
15 surface. Applying increased pressure on the opposite surface of the substrate is intended to loosen or dislodge contaminants from holes or openings in the substrate. Preferably the fluid pressure increasing means is provided in combination with a fluid pressure decreasing means;
20 conveniently these are disposed opposing one another, and thus will be on opposed surfaces of the substrate. Where both pressure increasing and decreasing means are provided, the pressure increasing means can serve to dislodge loose contaminants, while the pressure decreasing means can serve
25 to remove dislodged contaminants from the substrate, with the tacky surface removing any remainder of the

contaminant.

Preferably at least part of the moving means is arranged to move a substrate. Preferably also the moving means comprises a plurality of rollers which engage and
5 move a substrate.

Preferably an at least further part of the moving means comprises at least one roller upon which the tacky surface is provided. Preferably the apparatus includes urging means for urging the roller against a substrate
10 surface. Conveniently the urging means comprises a spring or the like. Preferably the tacky surface is provided upon a plurality of rollers. Preferably the plurality of rollers are mounted on a frame. Conveniently the rollers are selectively urgeable against a substrate; preferably
15 the frame is moveable such that a selected roller may be urged against a substrate. Conveniently, the frame is rotatable about an axis, and a plurality of rollers are mounted substantially equidistantly about said axis. Preferably three rollers are provided. This enables one or
20 more tacky rollers to engage with the substrate to be cleaned, and so collect contaminant from the substrate, while the other roller or rollers are disengaged from the substrate, and may be themselves cleaned or replaced, to remove collected contaminant. Further, a plurality of
25 rollers provides a greater surface area for contaminant collection than a single roller of equivalent volume,

thereby increasing the cleaning capability.

Preferably the apparatus further comprises a second tacky surface arranged to contact a portion of the first tacky surface, the second tacky surface being of greater tackiness than the first. Thus, the second surface may be used to transfer contaminant from the first tacky surface to the second, so enabling the first surface to continue collecting contaminant from the substrate. Preferably the second tacky surface and the first tacky surface are moveable relative to one another, such that portions of the surfaces in contact may be altered. Conveniently the second tacky surface may be in the form of a roller; preferably, however, the second tacky surface is in the form of an elongate sheet. Preferably also the sheet is mounted on a rotary take up reel. In this way used second surface may be gathered and stored on the reel, and subsequently removed for disposal or cleaning.

According to a second aspect of the present invention, there is provided a method of cleaning a surface of a substrate, the method comprising the steps of:

varying fluid pressure adjacent a portion of a substrate surface; and

contacting the substrate surface with a tacky surface.

In this way contaminants may be removed from the substrate.

The fluid pressure varying step may comprise the step

of increasing the fluid pressure adjacent the substrate surface; the varying step may alternatively or in addition comprise the step of decreasing the fluid pressure adjacent the substrate surface.

5 The method may further comprise the step of contacting the tacky surface with a second tackier surface.

These and other aspects of the present invention will now be described by way of example only and with reference to the accompanying drawings, in which:

10 Figure 1 shows a schematic of an apparatus for cleaning substrates in accordance with one embodiment of the present invention; and

Figure 2 shows a sketch of an air pump system of the apparatus of Figure 1.

15 Referring first of all to Figure 1, this shows an apparatus 10 for cleaning a substrate, such as a PCB, in accordance with one embodiment of the present invention. The apparatus 10 includes a number of rollers 12a, 12b, 12c, 12d which define a pathway along which a printed
20 circuit board (PCB) may move in the direction of arrow A. Rotation of these rollers 12a, 12b, 12c, 12d draws the PCB along the pathway. Disposed above the PCB pathway is a suction means in the form of suction ("vacuum") bar 14, which is connected via air lines 16 to a suction ("vacuum")
25 reservoir 18, which in turn is coupled to an air pump 20. The air pump 20 also drives a blower means in the form of

air knife 22, which is located beneath the PCB pathway, slightly upstream of the vacuum bar 14.

The air knife 22/vacuum bar 14 arrangement is shown in greater detail in Figure 2, which also illustrates the presence of an air filter 24 and a splash guard 26 in the vacuum trap 18.

Downstream of the PCB pathway from the air knife 22/vacuum bar 14 arrangement is a roller support frame 28 which is rotatably mounted (for anticlockwise rotation as shown in Fig 3) on a central pivot 30, and which bears three equidistantly spaced tacky rollers 32, each of which is biased axially from the frame 28 by means of springs 34. The tacky rollers 32 are elastomer rollers, commonly known as "blue" rollers, due to the colour of elastomer conventionally used to manufacture the rollers. Each roller 32 is rotatably supported by the frame 28 so as to be freely rotatable about an axis at a respective corner of 33 of the frame 28. The frame 28 is arranged such that the lowermost tacky roller 32 is in contact with a PCB passing along the pathway, while the uppermost two tacky rollers 32 are in contact with a tacky sheet 36 located above the frame 28. The tacky sheet 38 passes between a source reel 38 to a take-up reel 40, passing in contact with the uppermost tacky rollers 32.

Operation of the apparatus 10 is as follows. When a PCB 42 is to be cleaned, by removal of adhesive, for

example, the PCB 42 is fed between pathway rollers 12a, 12b. The rotation of these rollers 12a, 12b feeds the PCB 42 forward in the direction of arrow A, past firstly the air knife 22, and secondly the vacuum bar 14. The air
5 knife 22 blows air at high pressure upwards against the PCB 42, to loosen or dislodge any adhesive, eg. from holes formed in the PCB 42. The vacuum bar 14 creates a suction above the PCB 42, which draws any loose fragments of adhesive into the vacuum trap 18. The presence of the
10 splash guard 26 and air filter 24 prevent adhesive fragments from entering the air pump 20 and being recirculated.

The PCB 42 then moves past the tacky rollers 32, one of which is in the lowermost position. As the PCB 42
15 passes the roller 32, adhesive or other contaminants are transferred from the PCB 42 to the lower tacky roller 32. The PCB 42 then passes out of the apparatus 10, and may be reused.

Periodically, the roller frame 28 is rotated to bring
20 a new tacky roller 32 into contact with the PCB 42. The rotation may occur manually or automatically eg. after a predetermined time or number of PCB passes. The soiled roller 32 then contacts the tacky sheet 36, which is gradually being wound from the source reel 38, across the
25 tacky rollers 32, to the take up reel 40. As the sheet 36 is somewhat tackier than the reels 32, adhesive is

transferred from the soiled rollers 32 to the sheet 36, which is then wound onto the take up reel 40 to store the adhesive. When the take up reel 40 is full, or merely at regular intervals, the whole tacky sheet assembly may be removed for safe disposal of the removed adhesive. The cleaned sheet may then be replaced and re-used. Similarly, the vacuum trap 18 may be periodically removed and emptied to dispose of gathered adhesive.

The present invention has numerous advantages over conventional wet cleaning technology. First, there is no wet chemistry involved, with the associated disposal problems. Secondly, the apparatus may clean parts individually as necessary, and can do so in as little as 30 seconds, so there is less time lost from cleaning. Finally, the apparatus is relatively small and requires only an air supply and electricity supply to function, so can be easily moved and relocated within an assembly line.

It will be understood that the foregoing is for illustrative purposes only, and that numerous modifications and variations may be made thereto while remaining within the scope of the invention.

CLAIMS

1. An apparatus for cleaning a surface of a substrate, the apparatus comprising a tacky surface for contacting a substrate surface, moving means for moving a substrate and
5 the tacky surface relative to one another, and fluid pressure varying means for altering a pressure of a fluid adjacent a portion of the substrate.
2. The apparatus of claim 1, wherein the substrate is a
10 printed circuit board (PCB) substrate.
3. The apparatus of claim 1 or 2, wherein the fluid pressure varying means comprises a gas blower means which may cause localised pressure increases at or adjacent to the substrate surface.
- 15 4. The apparatus of claim 3, wherein the fluid pressure varying means further comprises a gas suction means which may cause localised pressure decreases at or adjacent to the substrate surface.
- 20 5. The apparatus of claim 4 wherein the gas blower means, in use, causes contaminant loosening and removal, and the gas suction means, in use, causes contaminant removal and

collection.

6. The apparatus of any preceding claim, wherein the fluid pressure varying means varies air pressure adjacent the substrate.

5 7. The apparatus of any preceding claim, wherein, in use, the fluid pressure adjacent the substrate is decreased.

8. The apparatus of claim 7, further comprising a vacuum trap or the like, to receive and store removed contaminant particles.

10 9. The apparatus of any preceding claim, wherein, in use, the fluid pressure adjacent the substrate is increased.

10. The apparatus of claim 9, wherein in use the increased pressure is applied on the same surface of the substrate as is to be cleaned.

15 11. The apparatus of claim 9, wherein in use the increased pressure is applied on the opposite surface of the substrate as is to be cleaned.

12. The apparatus of any preceding claim, comprising a fluid pressure increasing means in combination with a fluid

pressure decreasing means.

13. The apparatus of claim 12, wherein the fluid pressure increasing means and the fluid pressure decreasing means are disposed opposing one another.

5 14. The apparatus of any preceding claim, wherein at least part of the moving means is arranged to move a substrate.

15. The apparatus of claim 14 wherein the moving means comprises a plurality of rollers which engage and move a substrate.

10 16. The apparatus of any preceding claim, wherein at least part of the moving means comprises at least one roller upon which the tacky surface is provided.

17. The apparatus of claim 16 further comprising urging means for urging the roller against a substrate surface.

15 18. The apparatus of claim 17 wherein the urging means comprises a spring or the like.

19. The apparatus of claim 16, 17 or 18, wherein the tacky surface is provided upon a plurality of rollers.

20. The apparatus of claim 19, wherein the plurality of rollers are mounted on a frame.

21. The apparatus of claim 19 or 20, wherein the rollers are selectively urgeable against a substrate.

5 22. The apparatus of claim 20, wherein the frame is moveable such that a selected roller may be urged against a substrate.

23. The apparatus of claim 20 or 22, wherein the frame is rotatable about an axis, and a plurality of rollers are
10 mounted substantially equidistantly about said axis.

24. The apparatus of any one of claims 19 to 23, wherein three rollers are provided.

25. The apparatus of any preceding claim, further
15 comprising a second tacky surface arranged to contact a portion of the first tacky surface, the second tacky surface being of greater tackiness than the first.

26. The apparatus of claim 25, wherein the second tacky surface and the first tacky surface are moveable relative
20 to one another, such that portions of the surfaces in contact may be altered.

27. The apparatus of claim 25 or 26, wherein the second tacky surface is in the form of an elongate sheet.

28. The apparatus of claim 27, wherein the sheet is mounted on a rotary take up reel.

5 29. A method of cleaning a surface of a substrate, the method comprising the steps of:

varying fluid pressure adjacent a portion of a substrate surface; and

contacting the substrate surface with a tacky surface.

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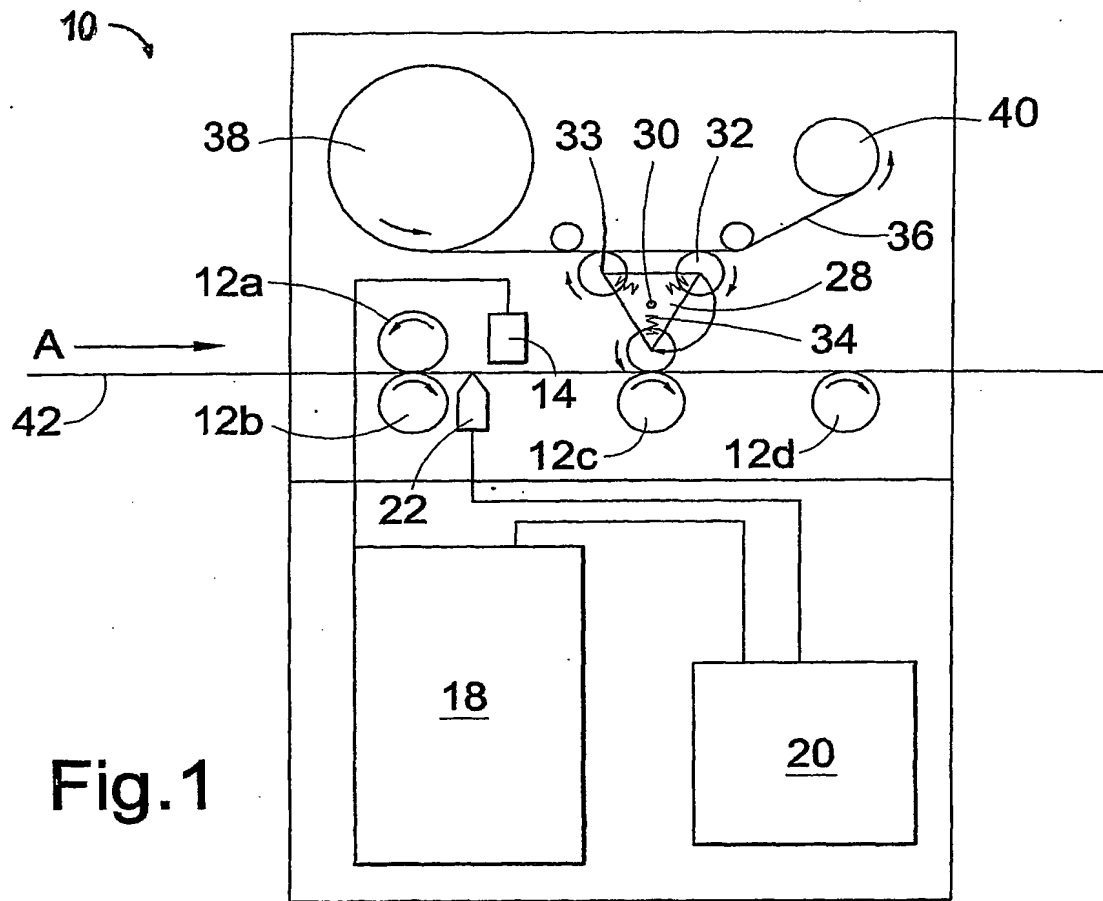
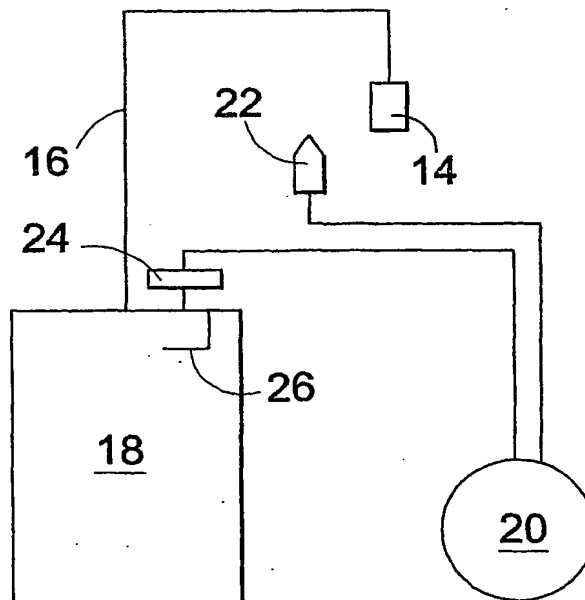


Fig.2



INTERNATIONAL SEARCH REPORT

Int. Application No

PCT/GB 01/04458

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 H05K3/26 B08B7/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 H05K B08B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

PAJ, EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 4 800 611 A (TORIWAKI ET AL.) 31 January 1989 (1989-01-31) the whole document	1-19
Y	---	20-26
A	US 5 251 348 A (CORRADO ET AL.) 12 October 1993 (1993-10-12) abstract; figures	19
Y	---	20-24
A	US 5 813 073 A (KORBONSKI) 29 September 1998 (1998-09-29) claims; figures	1,2, 14-20
Y	---	25,26
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☒ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

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Date of the actual completion of the international search

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INTERNATIONAL SEARCH REPORT

Inte Application No

PCT/GB 01/04458

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	PATENT ABSTRACTS OF JAPAN vol. 2000, no. 10, 17 November 2000 (2000-11-17) & JP 2000 200959 A (P C B PLANNING:KK), 18 July 2000 (2000-07-18) abstract -----	1,2,7, 14,16, 17,29
X	US 5 464 474 A (NISHIMOTO ET AL.) 7 November 1995 (1995-11-07) column 12, line 37 -column 17, line 34 column 23, line 33 -column 30, line 45 claims; figures 1,2,14-19 -----	1,3-19

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

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